PLASTIC CLOSURE, METHOD OF MANUFACTURE, AND CLOSURE AND CONTAINER PACKAGE FOR HIGH-TEMPERATURE APPLICATIONS

The present invention is directed to plastic closures for beverage, food, juice, pharmaceutical and like applications, and more particularly to a closure and method of manufacture that are particularly well suited for high-temperature (e.g., pasteurization, hot fill, asceptic fill and retort) applications.

Background and Objects of the Invention

It has heretofore been proposed to provide a plastic closure for a container, which comprises a plastic cap or shell with an interior liner for sealing engagement with the sealing surface of the container finish. For example, U.S. Patent 4,984,703 discloses a plastic closure that comprises a shell having a base wall with a peripheral skirt and a thread for securing the closure to a container finish, and a sealing liner compression molded in situ on the interior of the shell base wall. U.S. Patent 5,451,360 discloses a method and apparatus for compression molding the liner in situ within the closure shell. It has also been proposed to provide plastic resin barrier materials within the sealing liner for resisting transmission of gases (e.g., carbon dioxide and oxygen), water vapor and/or flavorants through the liner. For example, EP 0926078A1 discloses a plastic closure and method of manufacture in which the liner is compression molded in situ on the interior surface of the closure base wall, and includes a multiplicity of alternating layers of matrix polymer such as EVA and barrier polymer such as EVOH. EP 0926215A1 discloses a plastic closure and method of manufacture in which the liner is compression molded in situ on the interior surface of the closure base wall, and includes a dispersion of barrier polymer platelets, such as EVOH, dispersed within matrix polymer such as EVA.

Although the closures, the methods of manufacture, and the closure and container packages disclosed in the noted documents have addressed problems theretofore extent in the art, further improvements remain desirable. For example, it is desirable to provide a closure and liner construction, a method of closure manufacture, and a closure and container package that are particularly well adapted for high-temperature applications. Such high-temperature applications include, for example, applications in which the container is filled with product while the product is hot, such as so-called hot fill and asceptic fill applications. High-temperature applications also include applications in which the filled package is subjected to pasteurization or retort after filling. During retort applications, for example, the filled package may be subjected to a temperature of 265° F. for fifteen minutes. High-temperatures situations can also occur when a package is filled with a carbonated beverage and subjected to storage under high-temperature conditions, in which the internal pressure within the container can increase dramatically. In all of such high-temperature situations, the container closure is subjected to elevated internal pressure, which tends to distort or dome the closure base wall and lift the sealing liner away from sealing engagement with the container finish. It is an objective of the present invention to provide a closure, preferably a barrier closure, a method of closure manufacture, and a closure and container package that are particularly well suited for such high-temperature applications, and specifically in which the sealing liner of the closure remains in sealing engagement with the container finish during high-temperature situations.

Summary of the Invention

The present invention contemplates a number of different aspects or features, which may be implemented separately from or more preferably in combination with each other.

A two-piece plastic closure in accordance with a first aspect of the present invention comprises a plastic closure shell that includes a base wall and a peripheral skirt with

an internal thread or bead for securing the closure to a container finish. A plastic disk is loosely retained within the closure shell parallel to but separate from the base wall. A resilient sealing liner is molded in situ on the disk for sealing engagement with a container finish. The plastic disk preferably includes an annular ring underlying the liner on a side of the disk remote from the base wall. The ring is spaced from the closure skirt for urging the liner against the radially inner edge around the mouth of a container finish when the closure is secured to the container finish. Thus, even if the closure base wall is distorted or domed outwardly during a high-temperature situation, the annular ring maintains the liner in sealing engagement with the radially inner edge of the container finish.

The disk in the preferred embodiments of this first aspect of the invention preferably includes a flat circular base from which the annular ring extends coaxially with the circular disk periphery. The ring preferably has an S-shaped radially outwardly facing surface, including a rounded convex portion that extends from an axial edge of the ring and a rounded concave portion that extends from the convex portion to a flat axially facing surface on the base of the disk. The liner is urged against the axially facing sealing surface of the container finish and against the radially inner edge of the container finish by this S-shaped ring surface. The base of the disk has a central portion within the ring and a peripheral portion outside of the ring. The liner is preferably of uniform thickness over the central portion of the disk, over the ring and over the peripheral portion of the disk. The disk preferably includes an axially extending bead around a peripheral portion of the disk base to space the disk base from the base wall of the liner. The closure preferably includes a bead extending radially inwardly from the closure skirt adjacent to but spaced from the base wall, and the periphery of the disk is preferably loosely captured between the skirt bead and the base wall.

In some preferred embodiments in accordance with this first aspect of the invention, the disk further includes an annular rib around a radially outer edge of the disk base extending axially away from the base wall of the closure shell and underlying the liner for engaging the liner against a radially outer edge of the container finish. Thus, in this embodiment, even if the liner becomes separated from the container finish around the radially inner edge of the finish, sealing engagement is maintained between the liner and the container finish around the radially outer edge of the finish. The closure shell preferably has a bead extending radially inwardly from the skirt adjacent to but spaced from the base wall of the closure shell, and the annular rib on the disk preferably has a concave radially outwardly directed surface portion received over the skirt bead for holding the disk and liner in position within the closure.

In accordance with a second aspect of the present invention, a plastic closure includes a plastic shell having a base wall and a peripheral skirt with an internal thread or bead for securement to a container finish. A resilient sealing liner is urged by the base wall into sealing engagement with the container finish upon securement of the closure to the finish. An annular ring underlies the liner and is spaced radially inwardly from the skirt for urging the liner into sealing engagement with a radially inner edge of the container finish mouth. The ring may be provided either on the base wall of the closure shell, or on a separate plastic disk loosely retained within the shell parallel to but spaced from the base wall of the shell.

In accordance with yet another aspect of the present invention, a method of making a plastic closure includes providing a plastic closure shell having a base wall and a peripheral skirt with an internal thread or bead for securing the closure to a container finish. A plastic disk is placed within the closure shell against the base wall, and a resilient plastic liner is compression molded in situ onto the disk for sealing engagement with a container finish. In the preferred embodiments in accordance with this aspect of the invention, an internal bead is provided around the skirt of the closure shell adjacent to but spaced from the base wall, and the

disk is placed within the shell such that a periphery of the disk is loosely captured between the bead and base wall of the closure shell. The liner is compression molded over the disk, including a central portion of the disk, and preferably includes barrier material to resist migration of gases, water vapor or flavorants through the liner and the closure shell. The barrier material may comprise, for example, EVOH, crystalline semi-crystalline and amorphous nylons, acrylonitrile copolymers, blends of EVOH and nylon, especially amorphous nylon, nanocomposites of clay, especially smectite clay, with EVOH and/or nylon, blends of EVOH and an ionomer, cyclic olefin copolymers, or blends thereof.

A closure and container package in accordance with a further aspect of the present invention includes a plastic container having a body and a finish with an external thread, and a plastic closure that includes a shell with a base wall and a peripheral skirt with an internal thread securing the closure to the container finish. A plastic disk is retained within the closure shell between the base wall and an internal bead on the closure skirt. The disk includes a flat circular base with a peripheral portion captured between the bead and the closure base wall, and an annular ring extending axially from the base adjacent to but spaced from the periphery of the disk. A resilient liner is molded onto the disk underlying at least the central portion of the disk base and the ring that extends from the disk base. The ring urges the liner into sealing engagement with a radially inner edge of the container finish mouth when the closure is secured to the container finish. The liner is preferably molded in situ on the disk within the closure. The liner may include barrier materials to resist migration of gases (e.g., carbon dioxide or oxygen), water vapor and/or flavorants through the liner.

Brief Description of the Drawings

The invention, together with additional objects, features and advantages thereof, will be best understood from the following description, the appended claims and the accompanying drawings in which:

FIG. 1 is a partially sectioned elevational view of a closure and container package in accordance with one presently preferred embodiment of the invention;

FIG. 2 is a fragmentary sectional view of the portion of the package within the circle 2 in FIG. 1;

FIG. 3 is a fragmentary exploded perspective view of the container finish and closure in the embodiment of FIG. 1;

FIG. 4 is a top plan view of the plastic disk in the closure of FIGS. 1 - 3;

FIG. 5 is a sectional view taken substantially along the line 5 - 5 in FIG. 4;

FIG. 6 is an enlarged fragmentary sectional view of the portion of the disk within the circle 6 in FIG. 5;

FIG. 7 is a fragmentary partially sectioned elevational view of a closure and container package in accordance with a modified embodiment of the invention;

FIG. 8 is a fragmentary sectional view on an enlarged scale of the portion of the package within the circle 8 in FIG. 7;

FIG. 9 is a fragmentary exploded perspective view of the container finish and closure in the package of FIGS. 7 - 8;

FIG. 10 is a fragmentary sectional view similar to that of FIG. 6 but illustrating a portion of the closure disk in the package of FIGS. 7 - 9;

FIG. 11 is a fragmentary partially sectioned elevational view of a closure and container package in accordance with another embodiment of the invention;

FIG. 12 is a fragmentary sectional view on an enlarged scale of the portion of the package within the circle 12 in FIG. 11;

FIG. 13 is a fragmentary exploded perspective view of the container finish and closure in the package of FIGS. 11 - 12;

FIG. 14 is a fragmentary partially sectioned elevational view of the closure and container package in accordance with another embodiment of the invention;

FIG. 15 is a fragmentary sectional view on an enlarged scale of the portion of FIG. 14 within the circle 15;

FIG. 16 is an exploded perspective view of the closure and container finish in the package of FIGS. 14 and 15; and

FIG. 17 is a fragmentary sectional view similar to that of FIG. 15 but illustrating another embodiment of the invention.

Detailed Description of Preferred Embodiments

FIGS. 1 - 3 illustrate a closure and container package 20 in accordance with one presently preferred embodiment of the invention as comprising a container 22 having a body 24 from which a cylindrical finish 26 integrally extends. A closure 28 includes a base wall 30 and a cylindrical peripheral skirt 32 having one or more internal threads 34 received over one or more external threads 36 on container finish 26. Closure 28 preferably, but not necessarily, additionally includes a tamper - indicating band 38 connected by frangible bridges or a frangible web to the lower edge of skirt 32. (Directional words such as "lower" are employed by way of description and not limitation with respect to the upright orientation of the packages illustrated in the drawings, and directional words such as "axially" and "radially" are taken with respect to the axis of the container finish or closure skirt, as applicable. All dimensions are provided by way of example and not limitation.) A stop flange 40 extends from tamper-indicating band 38 into engagement with a bead 42 on container finish 26 so that, when closure 28 is removed from container 22, band 38 is separated from the closure skirt by rupture of the frangible ribs or web. Other types of tamper indicating means may be employed. To the extent thus far described, closure 28 and package 20 are of generally conventional construction. The closure is preferably of molded plastic construction. The container may be of glass or plastic construction.

In accordance with one aspect of the present invention, a liner disk subassembly 44 is loosely captured within closure 28 adjacent to base wall 30. Liner disk subassembly 44 includes a plastic circular disk 46 onto the undersurface of which a flexible resilient sealing liner 48 is secured. In the embodiment of FIGS. 1 - 3, liner 48 does not extend to the peripheral edge of disk 46. Referring to FIGS. 4 - 6, disk 46 includes a generally flat circular base having a central portion 50 and a peripheral edge 52. The disk base, including central portion 50 and peripheral edge portion 52, is of generally uniform thickness in the axial direction, and peripheral edge of the disk extends at constant radius entirely around the axis of the disk. A circumferentially continuous annular ring 54 extends axially downwardly from the disk base coaxially with the disk base. Ring 54 is adjacent to but spaced radially inwardly from the peripheral edge of disk 46, effectively separating central portion 50 from peripheral portion 52. As best seen in FIG. 6, ring 54 has a generally S-shaped radially outwardly facing surface formed by a convex portion 56 that extends from the rounded axial edge of ring 54, and a concave portion 58 that extends from convex portion 56 to the flat axially facing surface 60 of disk peripheral portion 52. The radially inwardly facing surface 62 of ring 54 is conical. A bead 64 extends axially upwardly from peripheral portion 52 around the peripheral edge of the disk for engagement with the opposing undersurface of closure base wall 30 (FIG. 2) to position the body of the disk parallel to but spaced from the opposing surface of the closure base wall. Bead 64 may be circumferentially continuous or segmented. In one presently preferred but exemplary embodiment of the invention for a 40mm retortable closure, disk 46 has a nominal outside diameter of 1.477 inches, and ring 54 has a nominal radial thickness of 0.148 inch. Surfaces 58, 56 both have a nominal radius of curvature of 0.030 inch, and the portion of ring 54 where surface 56 blends into surface 58 has a nominal angle of 120° with respect to the plane of the disk base. Surface 62 has a nominal angle of 27° with respect to the disk plane. Bead 64 has a

nominal axial height of 0.003 inch. Disk base 50 has a nominal thickness of 0.036 inch, and the overall height of the disk base plus ring 54 has a nominal dimension of 0.084 inch. Peripheral portion 52 has a nominal radial dimension of 0.081 inch.

Returning to FIGS. 1 - 3, a rounded bead 66 extends radially inwardly from closure skirt 32 adjacent to but spaced from the undersurface of closure base wall 30. Bead 66 may be circumferentially continuous or segmented. The peripheral portion 52 of disk 46 is loosely captured between bead 66 and base wall 30. (Liner disk subassembly 44 is loosely captured within the closure shell until the closure is secured to the container finish, at which point the liner disk is tightly clamped between the closure base wall and the container finish.) Liner 48 is preferably compression molded in situ onto disk 46 while the disk is captured within the closure. That is, disk 46 is first placed within the closure shell and captured between bead 66 and base wall 30, and liner 48 is then compression molded in situ onto the disk. Alternatively, but less preferably, the liner may be compression molded onto the disk, and the liner disk subassembly then assembled to the closure. Liner 48 may be of any suitable material construction. In accordance with the preferred embodiments of the invention, liner 48 is of resin construction, and most preferably includes a barrier material to resist permeation of gases, water vapor and flavorants through the liner. The liner is most preferably provided in accordance with the disclosure of one of the European publications noted above, the disclosures of which are incorporated herein by reference. Other suitable barrier liners or non-barrier liners may alternatively be provided. It will be noted in FIGS. 1 and 2 that liner 48 extends over the entire undersurface of disk 46 that is exposed in assembly to the interior of container 22. The liner extends over ring 54 and surfaces 56, 58, and onto flat surface 60 for at least a distance sufficient to engage the axial end of container finish 26 when closure 28 is secured to container 22. Ring 54 additionally urges the liner into sealing engagement with the radially inner edge of the

container finish mouth, so that the liner normally is in sealing engagement with both the axial end and the radially inner edge of the container finish. In FIG. 2, the phantom line 48a shows compression of the peripheral portion of the liner in sealing engagement with the container finish. Liner 48 is preferably of uniform thickness over the central portion of disk 46, over ring 54 and onto surface 60. By way of example, liner 48 may have a nominal thickness of 0.025 inch. In a tamper-indicating closure, the axial spacing between bead 66 and base wall 30 preferably is such that flange 40 of band 38 abuts bead 42 on finish 26, and fractures the frangible bridges or web, before bead 66 lifts liner disk subassembly 44 out of sealing engagement with the container finish. In this way, the closure will indicate tampering before the seal is broken.

FIGS. 8 - 10 illustrate a closure and container package 70 in accordance with a modified embodiment of the invention. (In all embodiments, identical reference numerals are employed to indicate identical or functionally related elements.) In package 70, the liner disk subassembly 72 comprises a circular disk 74 and a flexible resilient liner 76 molded thereon. Disk 74 includes a central base portion 50 and a peripheral portion 52, from which a circumferentially continuous annular rib 78 integrally extends. Rib 78 is disposed at the outer peripheral edge of peripheral disk portion 52, and extends axially therefrom coaxially with the disk base. The inner surface 80 of rib 78 is conical, extending axially and radially outwardly from flat surface 60 of disk 74. The radially outer surface of rib 78 has a concave recess or depression 82 that is received by snap fit in assembly over bead 66 on closure skirt 32. In a presently preferred embodiment of disk 74 for a 40mm retortable closure, rib 78 has a nominal axial dimension of 0.060 inch, surface 82 has a nominal radius of 0.035 inch, and bead 64 has a nominal axial dimension of 0.006 inch. All other dimensions are the same as those provided in connection with disk 46 in FIGS. 4 - 6. Liner 76 is molded over the entire undersurface of disk 74, including inside surface 80 of rib 78. As best seen in FIG. 8 with reference to phantom line

76a that shows the initial uncompressed geometry of the liner, the liner has a uniform thickness along the central portion of the disk, along ring 54 and along peripheral portion 52, but tapers in thickness axially along surface 80 of rib 78. Surfaces 56, 58, 60 and 80 of disk 74 urge liner 76 into sealing engagement with the radially inner edge, the axial end, and the radially outer edge of the container finish. Thus, even if pressure within the container is sufficient to distort or dome closure base wall 30 and disk 74 sufficiently for loss of sealing engagement at the radially inner edge of the container finish, sealing engagement is maintained along the radially outer edge of the container finish by disk rib 78 and the portion of the liner underlying the disk rib.

FIGS. 11 - 13 illustrate a closure and container package 84 in accordance with another aspect of the invention. In this package, the closure 86 does not include a liner disk subassembly captured within the closure. Instead, a flexible resilient sealing liner 88 is molded in situ directly onto the inside face of the closure base wall 90. The closure base wall 90 includes a ring 92 formed integrally with the closure base wall concentrically with the closure skirt and over which the liner 88 is formed. As best seen in FIG. 12, ring 92 on closure base wall 90 urges liner 88 into sealing engagement with the radially inner edge of container finish 26, while the flat axially facing surface 94 urges liner 88 into sealing engagement with the axial end of the container finish. Thus, package 84 functions in a manner similar to that of package 20 (FIGS. 1 - 3) discussed above, with the exception that liner 88 is molded directly onto the base wall of the closure rather than being provided in a separate liner disk subassembly captured within the closure.

FIGS. 14 - 16 illustrate a closure and container package 96 that includes container 22 and a closure 98. Closure 98 includes an internal shoulder 100 at the juncture of closure base wall 90 and peripheral skirt 32. Shoulder 100 has a radially inwardly oriented surface 102 that extends axially and radially outwardly from the adjacent flat surface 104 of the closure base wall

coaxially with the closure skirt. A flexible resilient liner 106 extends along the inner surfaces of base wall 30 and shoulder 100. Thus, shoulder 100 functions to urge liner 106 against the radially outer edge of closure finish 26, while the liner is simultaneously urged against the axial end of finish 26 by base wall surface 104, and against the axially inner edge of the container finish by the ring 92 around the closure base wall.

FIG. 17 illustrates a closure and container package 108, in which an annular wall 110 extends axially from closure base wall 90 at a position adjacent to and coaxial with closure skirt 32, but spaced radially inwardly from the closure skirt. Annular wall 110 may be spaced from skirt 32 entirely around annular wall 110, or may be coupled to the skirt by circumferentially spaced buttresses. Annular wall 110 has a radially inwardly directed conical surface 112. A flexible resilient liner 114 is compression molded in situ along the inner face of closure base wall 30, including ring 92, and along the radially inner face 112 of wall 110 for sealing engagement with the radially inner edge, the axial end and the radially outer edge of container finish 26 as previously described.

There have thus been described several embodiments of a plastic closure, a method of making such a closure, and a closure and container package, which fully satisfy all of the objects and aims previously set forth. All of the closures and packages possess superior sealing capability, particularly in high-temperature applications such as hot fill, asceptic fill, pasteurization and retort applications. The closures and packages also achieve superior barrier properties when barrier materials are included in the sealing liners of the closures. The invention has been described in conjunction with a number of aspects and embodiments, and a number of modifications and variations have been discussed. Other modifications and variations will readily suggest themselves to persons of ordinary skill in the art. The invention is intended to embrace all such modifications and variations as fall within the spirt and broad scope of the appended claims.